PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of

SMILANSKY, Zeev, et al.

Appln. No.: 10/003,347

Confirmation No.: 6579

Filed: December 06, 2001

For: A PIXEL BASED MACHINE FOR PATTERNED WAFERS

Docket No: Q67625

Group Art Unit: 2623

Examiner: Vikkram Bali

SUBMISSION OF APPEAL BRIEF

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith please find an Appeal Brief. Please charge Deposit Account No. 19-4880 the statutory fee of $500.00. The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account. A duplicate copy of this paper is attached.

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Respectfully submitted,

Alan J. Kasper
Registration No. 25,426

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE
23373
CUSTOMER NUMBER

Date: June 3, 2005

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For: A PIXEL BASED MACHINE FOR PATTERNED WAFERS

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with the provisions of 37 C.F.R. § 41.37, Appellant submits the following:

Table of Contents

I. REAL PARTY IN INTEREST

In compliance with 37 C.F.R. § 41.37, paragraph (c)(1)(i), based on information supplied by Appellant, and to the best of Appellants' legal representatives' knowledge, the real party in interest is the assignee, Applied Materials, Inc.

II. RELATED APPEALS AND INTERFERENCES

In compliance with 37 C.F.R. § 41.37, paragraph (c)(1)(ii), Appellants, as well as Appellant's legal representatives, state that they are not aware of any other prior and pending appeals, interferences or judicial proceedings which may be related to, may directly affect or may be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

In compliance with 37 C.F.R. § 41.37, paragraph (c)(1)(iii), Appellant hereby states that claims 1-4 and 26-29 are currently pending. Claims 5-23 are cancelled from the application. No claims are allowed. Appellant has appealed from the final rejection of claims 1-4 and 26-29. These claims, as finally rejected, are set forth in the attached Appendix.

IV. STATUS OF AMENDMENTS

In compliance with 37 C.F.R. § 41.37, paragraph (c)(1)(iv), Appellants hereby state that an amendment was filed on January 3, 2005 in response to the final rejection dated July 6, 2004. No claims were amended. In an Advisory Action dated January 13, 2005, the Examiner indicated that the amendment was entered for purposes of appeal but that all remaining claims continued to be rejected. A Notice of Appeal was filed on January 3, 2005, concurrent with the filing of the Amendment under 37 C.F.R. § 1.116.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

In compliance with 37 C.F.R. § 41.37, paragraph (c)(1)(vi), Appellants hereby provide a summary of the claimed subject matter, particularly as defined in a first set of claims based on independent claim 1 and a second set of claims based on independent claim 26. Claims 1 and 26 are the only independent claims under appeal.

The invention is directed to a pixel based inspection, rather than a pattern based inspection, of semiconductor wafers (specification at page 7, lines 1-3). The basis for such inspection is the scanning of individual pixels of the semiconductor wafer defining a "signature of each pixel." In the present invention, a determination is made as to whether such "signature of a pixel" has characteristics of a faultless or a defective pixel (page 11, lines 2-7). The phrase "signature of a pixel" (also referred to as a "pixel signature") is expressly defined by the Applicants as the area [of the wafer] covered by the spot of the beam at the moment the sampling is carried out (page 16, lines 19-22). In an exemplary and non-limiting example, the spot beam may have an elliptical shape and may have a dimension of 20 microns by 5 microns (page 30, lines 5-8). Needless to say, the phrase does not refer to a "pixel" that, in the display arts, means an element of a display image. The phrase may include an array of signature components, each of which is a signal that corresponds to the intensity of the light scattered by a pixel in a fixed direction, which may be azimuthally and/or elevationally distinct (page 29, lines 11-20). Each pixel signature has a sufficient number of bits to provide adequate information as to light intensity (page 35, lines 6-8).

The specification identifies the importance of pixel based inspection using a "signature of a pixel." Specifically, the Appellants taught in the specification that such pixel-based inspection can be performed without requiring reference pattern data. Moreover, using such technique, acceptable pixels and suspect pixels can be classified individually. Finally, there is no need to compare patterns or to use specific information about the patterns, in accordance with the teachings at page 9, line 25 - page 10, line 2. In this regard, a defective or suspect pixel is identified by a method chosen from among the group consisting of comparing the pixel signature to a master signature, comparing parameters of the pixel signature to ranges of acceptable parameters, or determining the position of the pixel signature in statistics of such signatures. In short, throughout the entire specification, the distinction from, and benefits of, a pixel-based analysis is taught and is distinguished over a pattern based analysis as in the prior art.

The basic focus of the invention in claims 1, 2 and 4 claims is on a method of detection of defects on a semiconductor wafer, where the method includes detecting suspected pixels by collecting the "signature of each pixel," and determining whether the signature has the characteristics of a signature of a faultless pixel or of a pixel that is defective or suspect to be defective. The signature of a pixel is defined by the way in which (1) the pixel alone responds to(2) a light of a scanning beam (3) without reference to adjacent pixels.

The invention as defined in claims 3 and 26-29 is directed to a method that includes detecting light scattered by an illuminated portion of the surface of the semiconductor wafer as plural individual pixel signatures. The invention of claim 3 uses a signature of a pixel as defined in claim 1. The invention of claims 26-29 further evaluate the plural pixel signatures according

to a predetermined criterion, and discriminating between valid and at least one of suspect and defective pixels. For claims 26-29, the "pixel signature" is expressly defined to be "without reference to adjacent pixels."

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

In compliance with Section 41.37, paragraph (c)(1)(ii), Appellants hereby provide a concise statement listing each ground of rejection presented for review:

1. Rejection Under 35 USC 103

Claims 1-4 and 26-29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Alumot et al (5,699,447) in view of Tsai et al (4,845,558).

The Examiner points to the patent to Alumot et al for a teaching of a method for detection of defects on semiconductor wafers (col. 12, lines 1-7) that is alleged to involve a methodology of first getting a reference value by computing the type of each pixel, considered to be an "individual pixel." The Examiner asserts that in a subsequent step, the same methodology is performed during an inspection process. The Examiner finds that Alumot et al determines the manner in which a pixel responds to the light of a scanning beam and notes that at col. 1, lines 15-19, a photo detector detects the presence of a particle by collecting light scattered by the particle. The Examiner states that this is read as "pixel responds to the light scanning beam."

Recognizing that the comparison to Alumot et al has deficiencies, particularly with the definition in the claim of a "signature of a pixel," the Examiner looks to Tsai et al for a wafer defect detection method that is conducted "pixel-by-pixel." The Examiner asserts that Tsai et al, at col. 3, lines 42-52, provides a teaching that a system where "signature of each pixel" is determined by "the pixel alone and without reference to adjacent pixels," as in claim 1. The

Examiner also asserts that the pixel-by-pixel" technique of Tsai et al is a measurement "without reference to adjacent pixels," as in claim 26.

VII. ARGUMENT

ISSUE 1 - Claims 1, 2 and 4 are not unpatentable over Alumot et al (5,699,447) in view of Tsai et al (4,845,558) under 35 USC 103(a).

Key to the distinction over the prior art is the definition and understanding of the terms "signature of each pixel," where the response to light is based upon the "pixel alone...without reference to adjacent pixels," as in claim 1, and "pixel signature," where there is no "reference to adjacent pixels." The terms "signature of each pixel" and "pixel signature" are clearly defined in the specification, are limited by the remarks of the Applicant in the prosecution history of present application, and would be understood by one skilled in the art to be limited to a response without. The invention, as defined by these terms, clearly is not taught in the cited art, as subsequently demonstrated.

The Invention

Pixel Based Inspection

A core feature of the present invention is that it is directed to a pixel based inspection, rather than a pattern based inspection of semiconductor wafers (specification at page 7, lines 1-3). As explained at page 10, lines 2-13, the invention is based on identifying defective pixels (1) without reference to a pattern to which the pixel belongs, (2) to the position of the pixel on the wafer, or (3) without comparison between patterns. The first exception is particularly important as it clearly indicates that adjacent pixels or pattern features are not considered when evaluating a pixel. Conventional approaches to defect detection rely upon the response of a given pixel and

its adjacent pixels to determine a pattern or output characteristic, a basis for response that is not relied upon in the present invention.

Scanning of Individual Pixels

The basis for the comparison made according to the present invention is the scanning of an individual pixel of the semiconductor wafer defining a signature of each pixel. In the present invention, a determination is made as to whether the pixel signature for an individual pixel has characteristics of a faultless or a defective pixel (page 11, lines 2-7). All of the rejected claims refer to the detection of the signature of each pixel. This term "pixel" is expressly defined as the area [of the wafer] covered by the spot of the beam at the moment the sampling is carried out" (page 16, lines 19-22). By virtue of this definition, the spot beam serving as a source of light does not illuminate other pixels and their features would not and cannot be considered.

The term "signature of a pixel' is expressly stated in claims 1. 2 and 4 to mean "the way in which the pixel alone responds to the light of a scanning beam without reference to adjacent pixels." (emphasis added) This limitation means that none of the intensity, shape, pixel type , proximity or other characteristics of adjacent pixels are considered in extracting a pixel signature. In other words, there is no interference from light reflected by adjacent areas or pixels, leading to a more accurate signal for analysis and decision making.

The foregoing interpretations of the claims have been presented consistently by the Applicants in the previous amendments made in the filings dated February 20, 2003, August 7, 2003, May 28, 2004 and January 3, 205. The same interpretation was presented in an interview conducted with the Examiner on July 16, 2003 and was the basis for an amendment to claim 1

and the drafting of new claim 26, which emphasized the definition of a "pixel signature" and "signature of a pixel."

Alumot

The patent to Alumot teaches the inspection of a wafer using strings of pixels of images related to an inspected pattern and a reference pattern. Alumot et al detects the pattern using plural detectors 5, arranged around an object W under inspection. The use of such patterns is clearly distinguished in the background section of the present application. Moreover, the Examiner admits that Alumot et al fails to disclose the detection of a pixel alone and without reference to adjacent pixels.

The teachings in Alumot et al reflect the technology in the time frame of the early 1990's. Advanced defect detection technology of that time, which focused on in semiconductor manufacturing processes, considered comparisons that were designated to be "pixel-by-pixel" to be based at least on both intensity and "pixel type." As taught at col. 10, lines 47-54, the pixel type is based on signal intensity and shape in a 3x3 neighborhood. The characteristics were always determined with reference to adjacent pixels, as is clear from the pixel-by-pixel comparison in Alumot et al that uses surrounding pixels as a basis for analysis (col. 23, lines 34-51).

As explained at col. 19. line 52-col. 20, line 28 of Alumot et al, the function of the image comparator 77 is to carry out a comparison between the inspected image in the vicinity of a current pixel and the referenced image in the vicinity of the corresponding pixel. Alumot et al teaches that this involves something more than a signature(s) of the a single pixel. Specifically,

this comparison is based on a 3x3 neighborhood matrix centered on a pixel of interest, Thus, a single pixel is compared to the 9 pixels in the 3 x 3 neighborhood centered at the corresponding reference pixel. Each of 9 comparisons is made by the comparing the difference between energy of the compared pixels against a threshold determined by the pixel type. The energy of a pixel is the sum of the 9 pixels in the 3 x 3 neighborhood at the pixel. The phase 2 examination, which is disclosed beginning at col. 21, line 73 is similar in its "pixel-by-pixel" comparison, in that the neighborhood and vicinity of a subject pixel must be considered in determining the characteristics of any given pixel.

In sum, Alumot et al is focused exclusively on pattern comparisons and the use of adjacent pixels when performing a defect analysis.

Tsai et al

The Examiner looks to Tsai et al for another teaching of a "pixel-by-pixel" comparison for detecting defects on a wafer. However, this reference, which reflects technology from the late 1980's, even earlier than that of Alumot et al, teaches nothing more than the comparison of a given pixel characteristic that is necessarily based on other pixels in the neighborhood or vicinity. The technology of the time would not allow an examination of a single pixel alone without considering other pixels in the neighborhood or vicinity in determining the characteristics of a given pixel. The technology of the time would not allow an illumination of a spot on an object having a size that defines the pixel, as in the present invention. In sum, Tsai et al does not and cannot generate a "signature of a pixel" as that term is defined in the claims and as supported by the specification.

The Examiner has not provided any rebuttal to this clear basis for distinction, nor can he do so as the technology of the time could not detect light from a single pixel without considering other adjacent pixels.

First, Tsai et al teaches at col. 3, lines 28-56 that, following an alignment, the magnification of the zoom lens is such that repeated portions of a pattern on a semiconductor are caused to fill an aperture 26 of a camera 20, and the zoom further adjusted so that "a period or pitch 'P' of the repeating pattern in the image is equal to the dimension of an integral number of detection pixels." The image cast upon the sensitive surface of the camera 20 is a "predetermined number of pixels." Clearly, this is not an illumination of a single pixel or a detection of a signature of a single pixel, even though Tsai et al states that the multiple number of pixels are compared on a "pixel by pixel" basis. Clearly, given the size of the detected area and camera aperture, interference from adjacent pixels cannot be avoided.

Second, Tsai et al teaches at col. 3, lines 57-68 that the detection process requires an overlay by a pixel grid 35, and that a comparison of pixels in a pattern will indicate whether or not one of the compared feature is different and thus defective. The example given is of 3x3 array of pixels 41 covering a portion of the feature 40, that are compared to a corresponding pixel or the corresponding set of pixels 43 covering the feature 42. A detected difference would evidence the presence of a defect 45. At col. 4, lines 1-4, Tsai et al notes that information contained in a single pixel 50 or group of pixels 52 can be compared to corresponding information in a data base. However, even the comparison of a information for a single pixel is not a comparison of a "signature of a pixel" or a "pixel signature," as it is not the way a "pixel

alone responds to light of a scanning beam" as recited in claims 1, 2 and 4. Again, the use of a large aperture and a consideration of light from adjacent areas to a given pixel will necessarily preclude the consideration of a pixel signature comprising the light from a pixel "alone."

In sum, the technique used by Tsai et al is not, and cannot be, a generation and use of a "signature of a pixel," as claimed.

Claims 1, 2 and 4 Are patentable For Several Reasons

The Express Limitations of the Claims Are Not Found in the Prior Art

Claims 1, 2 and 4 expressly state that the pixel signature is based upon "the pixel alone" and all or the rejected claims state that a comparison is made "without reference to adjacent pixels." These are clear limitations of the claim and are based upon an express disclosure in the present application. These limitations must be found in the prior art for a proper rejection. Nothing in the prior art teaches these limitations.

First, as to Alumot, as already discussed, there is no relevant teaching. The "pixel-by-pixel" comparisons are expressly based on neighboring pixels in a matrix, or those in the vicinity.

Second, as to Tsai et al, the "pixel-by-pixel" comparison does not generate a "signature of a pixel" as defined by the Appellants. As already demonstrated, at the time of the filing of Tsai et al, the term meant a comparison of features in the neighborhood or vicinity of a given pixel. Figures 2-5 in Tsai et al clearly demonstrate a macro view of the object that considers several "pixels" within the field of illumination and within the field of view. Tsai et al does not

teach the detection of a "signature of a pixel," as defined by the Applicant in the specification and claims.

In Tsai et al, the text at col. 3, lines 42-52 refers to an inspection of features of the pattern where "the pixel or pixels containing the subject pattern are compared to any other pixel or group of pixels containing the same feature, and if there is a material variance between the two, then a defect has been detected." The above quoted text is insufficient to teach an evaluation of a pixel that is the size of a scanning beam or the evaluation of a pixel without reference to other pixels. The only teaching is of a "pixel-by-pixel" comparison. There is no express statement of the basis for that comparison. However, the illustration of plural pixels in the detection field of Fig. 5, for example, clearly demonstrates a meaning based on a consideration of other pixels in the neighborhood or vicinity. Thus, even if one pixel's features may be compared to another pixel's features, those features are determined on the basis light reflected from adjacent pixels. Nothing in Tsai et al suggests that the effect of other pixels should be avoided, and indeed, the clear impression of the teaching in both references is that the field of view for the camera is a matrix or group of pixels.

Appellants respectfully submit that the Examiner has improperly used the Appellants' own teachings to recreate a definition of "pixel signature" without support in any prior art reference. Moreover, Applicants' definition is expressly provided in the claim and not just by interpretation of the specification. Thus, the Examiner cannot simply extrapolate from the limited teachings of Alumot et al and Tsai et al to find a proper basis for unpatentability, but

must find an express teaching in the prior art of a "pixel signature" that is based upon "the pixel alone" and "without reference to adjacent pixels." This has not been done.

In the absence of any teaching in either reference of the claim limitation that requires the use of the signature of each pixel, defined by the way in which the pixel alone responds to the light of a scanning beam without reference to adjacent pixels, the claims cannot be considered unpatentable.

The Cited Prior Art References Are Incompatible

Not only do the prior art references fail to teach the claimed invention, they are incompatible and would not be combined by one skilled in the art. First, Alumot et al teaches a pattern based detection using plural separate detectors. As is clear from Figs. 1 and 6, and the teachings at col. 7, line 33- col. 9, line 13, multiple detectors 5 are arranged around a pattern on the wafer W and provide separate outputs taken from different angles, but capture the inputs from multiple pixels in the field of illumination and that are presented as an array of pixels. The patent expressly disclaims inspection of patterned wafers using CCD devices on a pixel-by-pixel basis at col. 1, lines 24-50.

Second, Tsai et al teaches a pixel-by-pixel-based detection using a single TV camera 30, linear sensor array 70 or detector 88. The result is a single image broken into a matrix or array of pixels as illustrated in Figs. 4 and 5.

The disclaimer by Alumot et al of the Tsai et al type of detector precludes their combination. Moreover, based upon the goal of Alumot et al to avoid the technology in Tsai et

al, there is an inherent incompatibility. Finally, in view of this disclaimer, there cannot be any teaching or suggestion as to how the multiple detectors of Alumot et al may be substituted into Tsai et al, or how the single detector of Tsai et al may be substituted for the plural detectors of Alumot et al. Indeed, Appellants would submit that the two systems are incompatible in both structure and result.

Even if the Examiner disclaims an assertion that the detectors of Alumot et al would be substituted for the detector of Tsai et al, but simply advocates that the processing of Alumot's several outputs could be performed according to the teachings of Tsai et al, this suggestion ignores the substantially different processing that would be required of plural separate images and the complications that are involved when attempting to filter down to a single pixel. How and why such modification would occur is nowhere presented in either reference, or otherwise identified in the prior knowledge of one skilled in the art. Moreover, the integration of the structure or processing of Tsai et al for the structure of Alumot et al, in view of the clear disclaimer in Alumot et al, would require the impermissible use of hindsight.

In short, the claimed subject matter would not be obvious from the teachings of Alumot et al in view of Tsai et al.

ISSUE 2 -Claims 3 and 26-29 are not unpatentable over Alumot et al (5,699,447) in view of Tsai et al (4,845,558) under 35 USC 103(a).

The subject matter of claims 3 and 26-29 differ from that of claims 1, 2 and 4 in that they require multiple pixel signatures from the illumination of a single pixel by a scanning beam.

Again, the definition of "signature of a pixel" would limit the illuminated area to a single pixel and would limit the reflected light to that coming from the pixel alone. Claim 3, which depends from claim 1, would be patentable for the reasons already given for claim 1.

Claims 26-29 similarly use a definition of "pixel signature" that is similar to that used in claims 1-4 and would overcome a rejection based on the teachings of Alumot et al and Tsai et al for the reasons already given.

Moreover, claims 3 and 26-29 have an even clearer distinction from the combination of Alumot et al and Tsai et al, based upon the detection of multiple pixel signatures or signatures of a pixel.

First, as to Alumot et al, the failure of this reference to teach an analysis based on the detection of a single pixel signature already has been presented and is admitted by the Examiner. While Alumot et al uses plural detectors 5 to receive the light reflected from a specimen W on a table 2, as illustrated in Fig. 1, the detection is of the light from plural pixels in the area under analysis. There is no teaching that light from a single pixel is detected by plural detectors, thus resulting in plural pixel signatures, as claimed.

Second, as already noted, Tsai et al uses only a single objective lens (16, 84) in all of the embodiments to capture the reflected or transmitted light and direct it to a camera or CCD array. Tsai et al cannot detect plural pixel signatures with the disclosed structure. There is no teaching or suggestion that plural signatures may be detected at one time, as claimed.

Third, there is no basis in the cited and applied references for modifying either Alumot et al to detect only a single pixel, or for modifying Tsai et al to have multiple detectors for detecting multiple pixel signatures. It would require the impermissible use of hindsight to modify either reference in light of the teachings of the other and to arrive at the claimed invention. Moreover, as already noted, there is no detection of a "pixel signature" in either reference.

Fourth, as previously asserted, the two references are incompatible, as Alumot et al teaches a pattern based detection using plural separate detectors, while Tsai et al teaches a pixel-by-pixel-based detection using a single camera or detector. Substitution of the structure of Tsai et al for the structure of Alumot et al would require the impermissible use of hindsight.

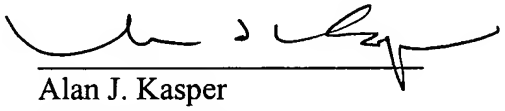
CONCLUSION

On the basis of the foregoing, all of claims 1-4 and 26-29 would be patentable over the cited art. Accordingly, reversal of the Examiner's rejections is respectfully requested.

Unless a check is submitted herewith for the fee required under 37 C.F.R. § 41.37(a) and 1.17(c), please charge said fee to Deposit Account No. 19-4880.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



Alan J. Kasper
Registration No. 25,426

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

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23373
CUSTOMER NUMBER

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CLAIMS APPENDIX

CLAIMS 1-4 and 26-29 ON APPEAL:

LISTING OF CLAIMS:

1. Method for the analysis of surfaces, particularly for the detection of defects on semiconductor wafers, which comprises checking individual pixels of the surface under control, and detecting suspected pixels by collecting the signature of each pixel, defined by the way in which the pixel alone responds to the light of a scanning beam without reference to adjacent pixels, and determining whether said signature has the characteristics of a signature of a faultless or of a pixel that is defective or suspect to be defective.

2. Method according to claim 1, comprising analyzing the signature of each pixel to determine the presence of foreign particles.

3. Method according to claim 1, wherein a pixel signature is defined by an array of signature components, each of which is a signal which corresponds to the intensity of the light scattered by the pixel in a fixed direction.

4. Method according to claim 1, comprising detecting defective or suspect pixels by a method chosen from among the group consisting of comparing the pixel signature to a master signature, comparing parameters of the pixel signature to ranges of acceptable parameters, or determining the position of the pixel signature in a statistics of such signatures.

26. A method of analyzing the surface of a semiconductor wafer comprising:

illuminating a portion of the surface of the semiconductor wafer with light;

detecting light scattered by the illuminated portion of the surface of said semiconductor wafer as individual pixel signatures, said pixel signature being defined without reference to adjacent pixels;

evaluating said pixel signatures according to a predetermined criterion;

discriminating between valid and at least one of suspect and defective pixels.

27. The method of claim 26, wherein a plurality of pixels is illuminated and checked concurrently.

28. The method of claim 26 further comprising outputting a defect list of detected defective pixels.

29. The method of claim 26 wherein said detecting step comprises detecting the intensity of light at a plurality of locations disposed about the illuminated portion of the surface.

EVIDENCE APPENDIX:

In compliance with 37 C.F.R. § 41.37(c)(1)(ix), Appellant states that there is no evidence submitted pursuant to 37 C.F.R. §§ 1.130, 1.131, or 1.132 or any other evidence entered by the Examiner and relied upon by Appellant in the appeal. Appellant assumes that the cases cited in support of its position are readily available to the Board and need not be submitted in fulfillment of this requirement.

RELATED PROCEEDINGS APPENDIX

In compliance with 37 C.F.R. § 41.37(c)(1)(ii), Appellant states that there are no decisions rendered by a court or the Board in any proceeding identified in Section II.